Shellfish and Climate Change

Ecological and Economic Effects

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Washington State Climate Conference

Dan Cheney and Bill Dewey
Pacific Shellfish Institute
Olympia, Washington

Extent and Range of Shellfish Stocks and Harvests

- Oysters, clams, mussels, geoducks and other bivalves
- Crab, shrimp, sea urchins, sea cucumbers, octopus and abalone
- Other invertebrates (shellfish)
  - There are 1,000s of additional taxa or types ranging from the smallest zooplankton to giant squid
  - Many are important in the food chain or life history of harvested shellfish, fish and wildlife

Economic value – farmed bivalve shellfish

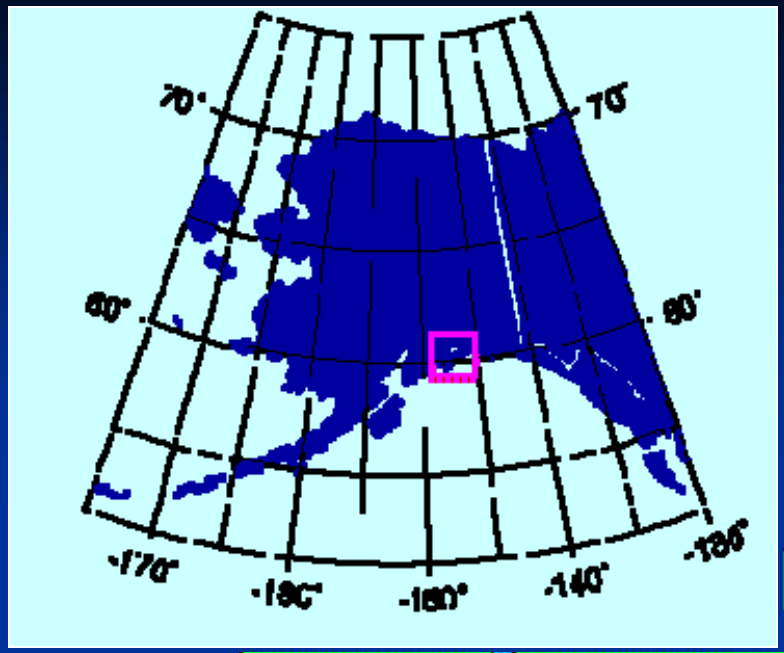
	OYSTERS	CLAMS	MUSSELS	GEODUCK	TOTAL
Wash:	77 mil lbs	7 mil lbs	1.5 mil lbs	400,000 lbs	85.9 mil lbs
	$57.75 mil	$14 mil	$1.73 mil	$2.5 mil	$75.98 mil
Calif:	10 mil lbs	6,000 lbs	600,000 lbs	No Record	10.61 mil lbs
	$7.5 mil	$12,000	$1.05 mil		$8.56 mil
Oregon:	5 mil lbs	No Record	No Record	No Record	5 mil lbs
	$3.75 mil				$3.75 mil
Alaska:	920,000 lbs	41,000 lbs	3,000 lbs	No Record	964,000 lbs
	$400,192	$115,038	$5,419		$523,060
TOTALS:	92.9 mil lbs	7.0 mil lbs	2.1 mil lbs	400,000 lbs	102.5 mil lbs
	$69.4 mil	$14.1 mil	$2.8 mil	$2.5 mil	$88.8 mil

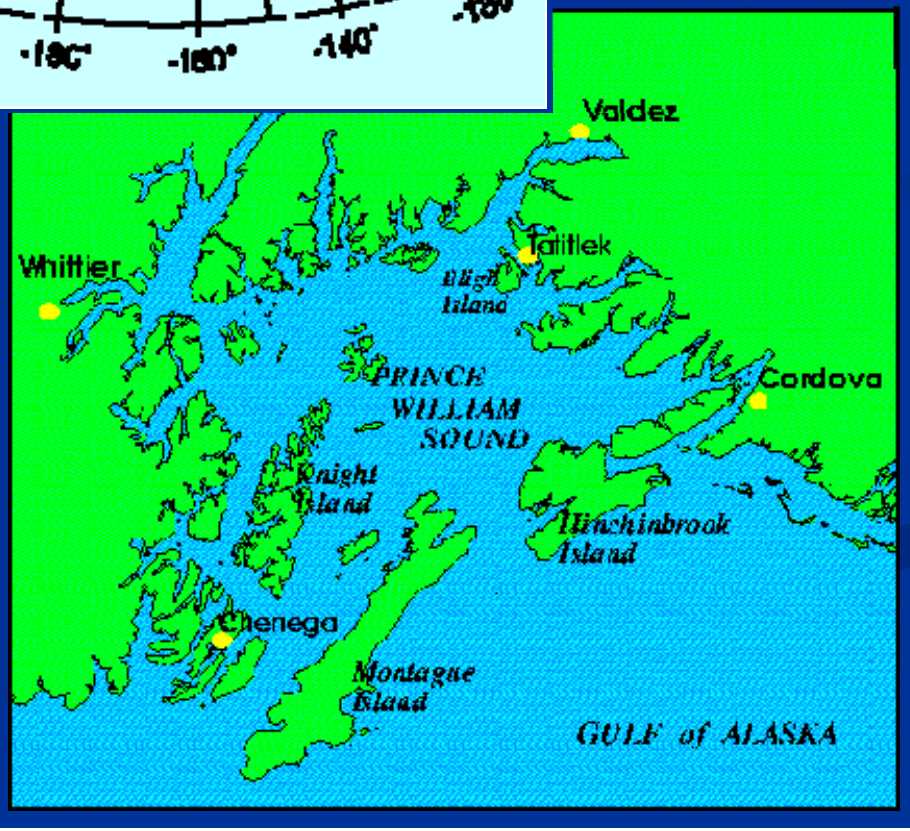
Key Environmental Issues

Climate change factors likely to affect shellfish growth, reproduction, distribution, health, and our ability to farm and manage:

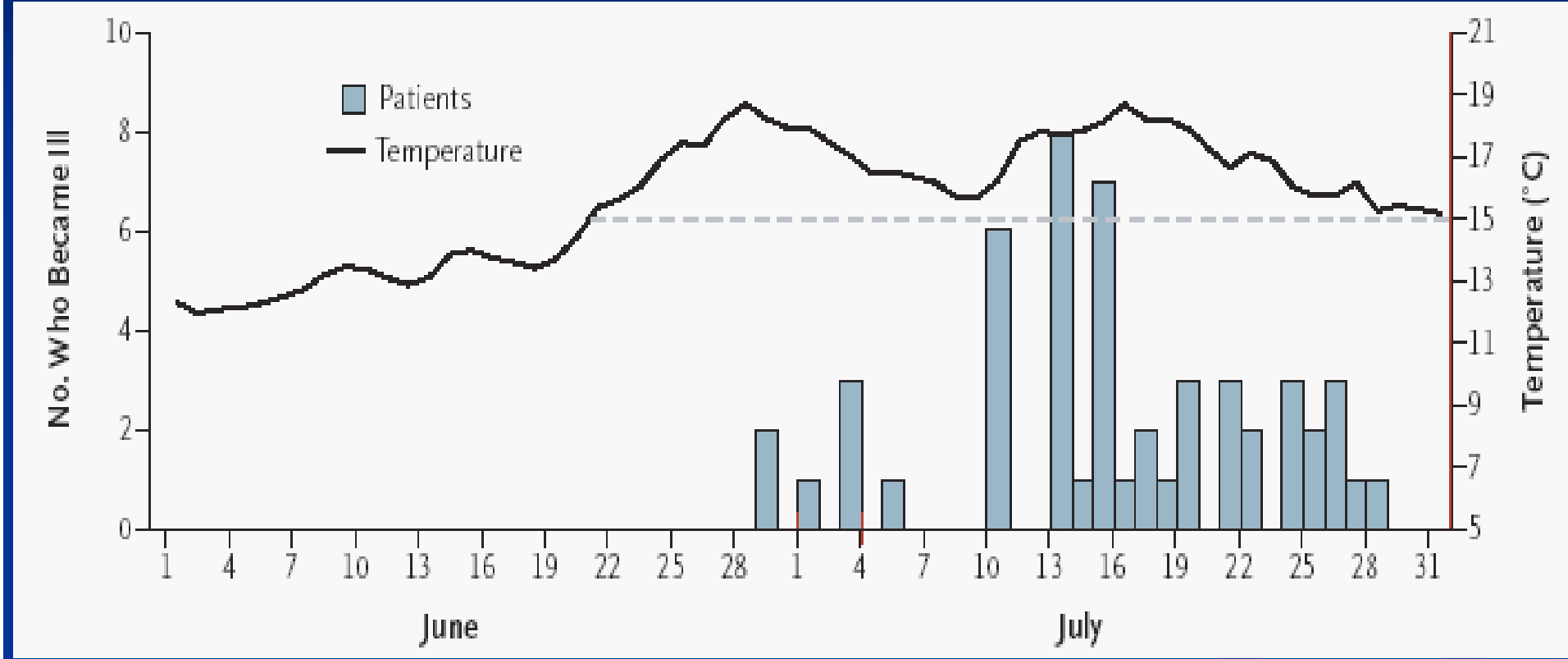
- Water temperature
- Sea level change
- Water currents and circulation
- Freshwater runoff
- Extreme events

“Oyster-related illness linked to warming ocean”



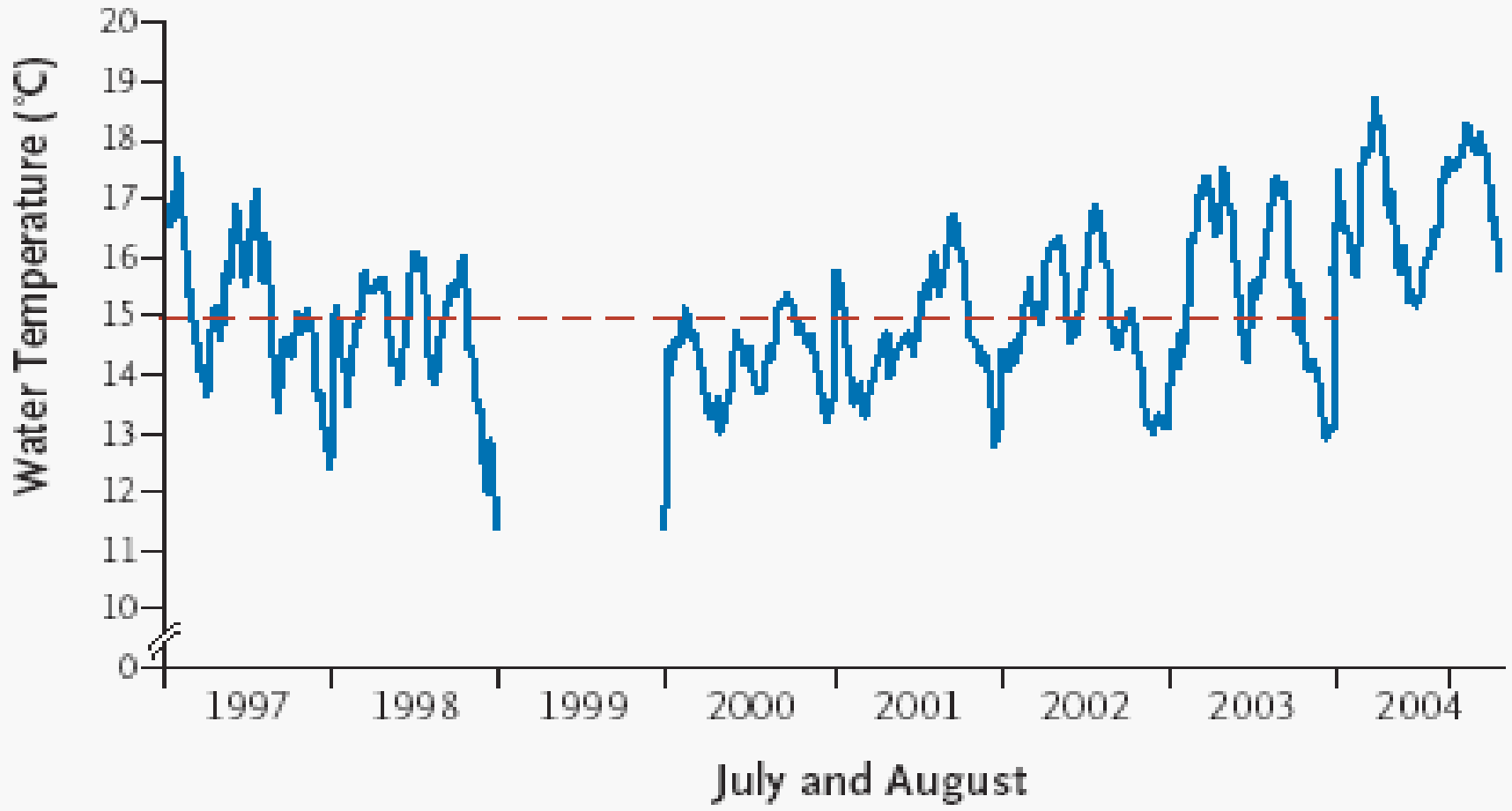


Number of Patients with *Vibrio* Infection Associated with Oysters

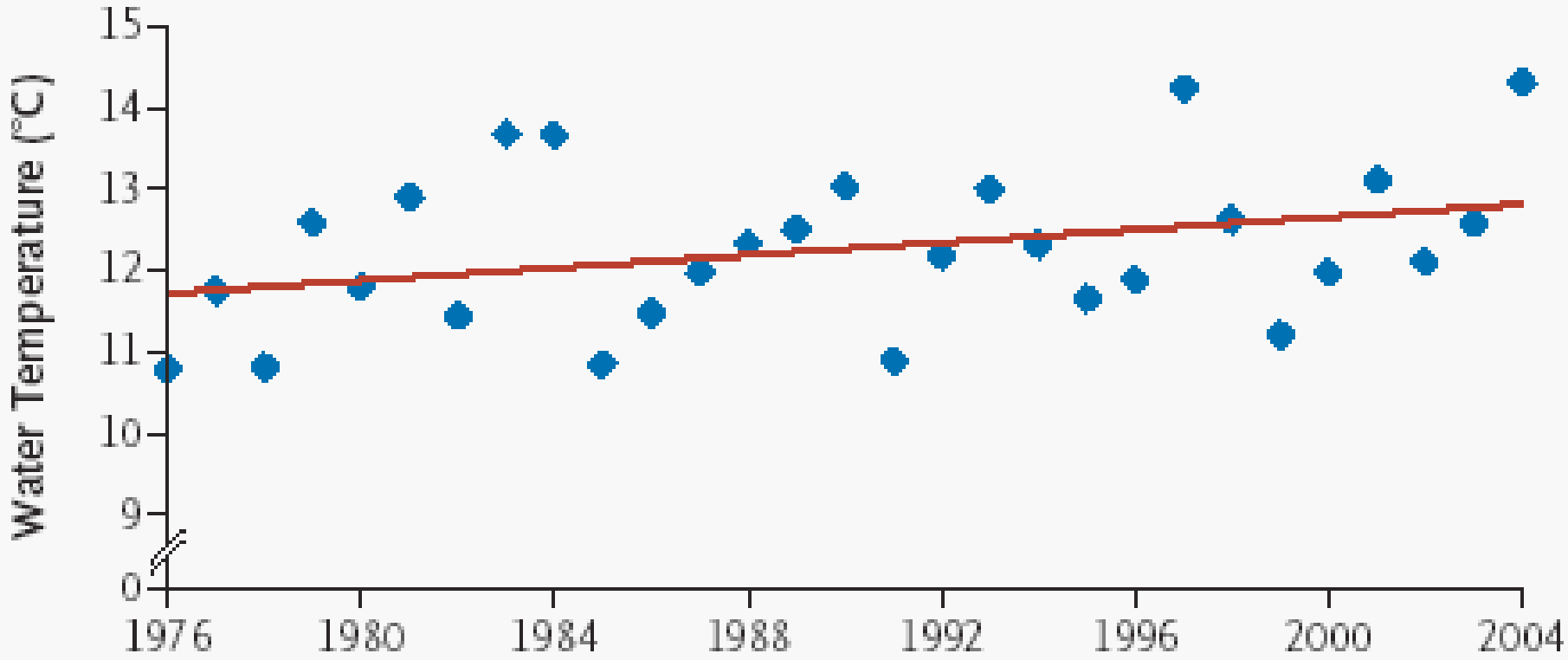


McLaughlin, Joseph B., et al. (2005) Outbreak of *Vibrio parahaemolyticus* gastroenteritis associated with Alaskan oysters. New England J. Med. 353:1463-70.

Mean Daily Water Temperatures in Prince William Sound



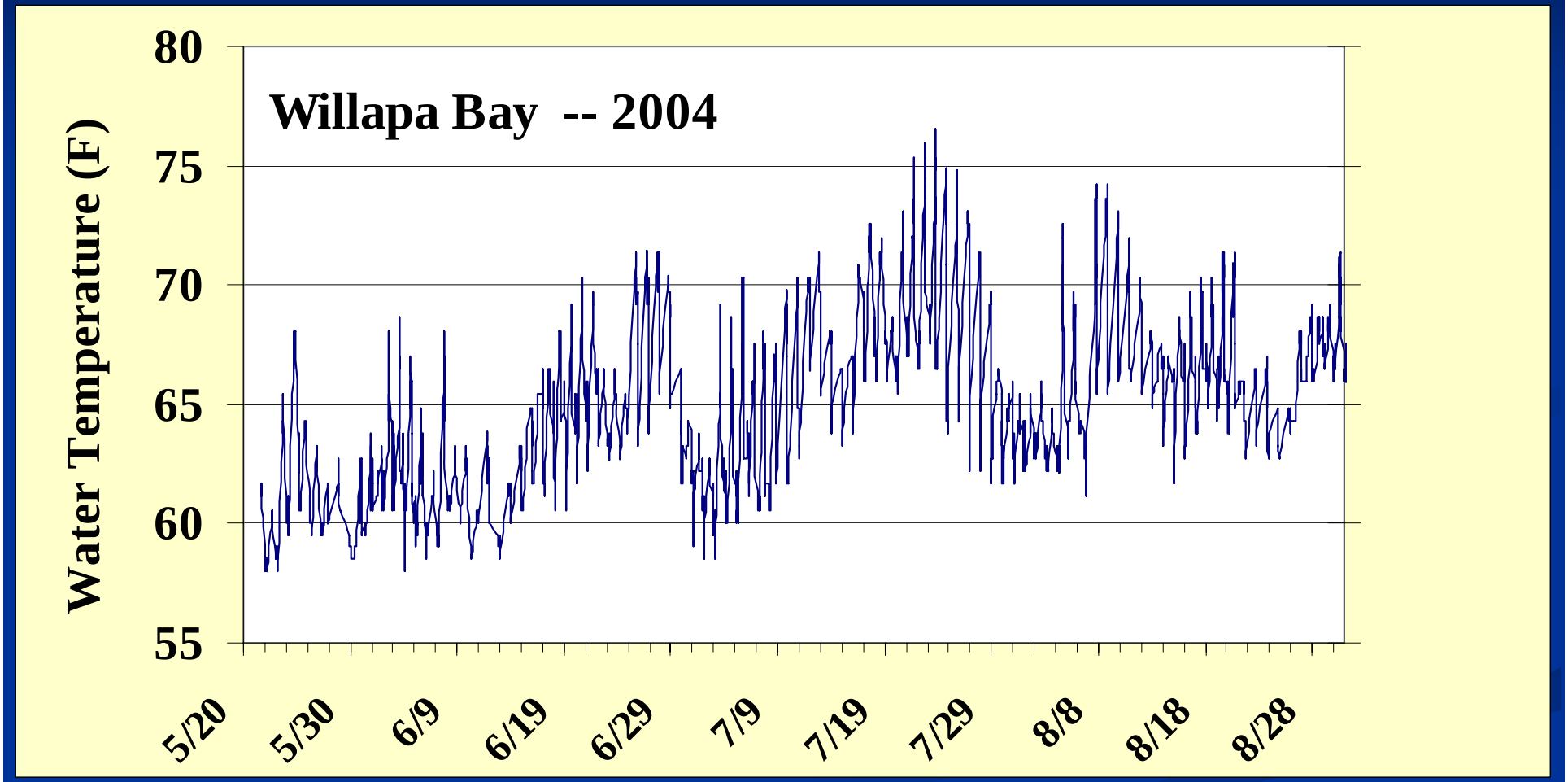
Surface-Water Temperatures in July and August in the Gulf of Alaska, 1976 to 2004



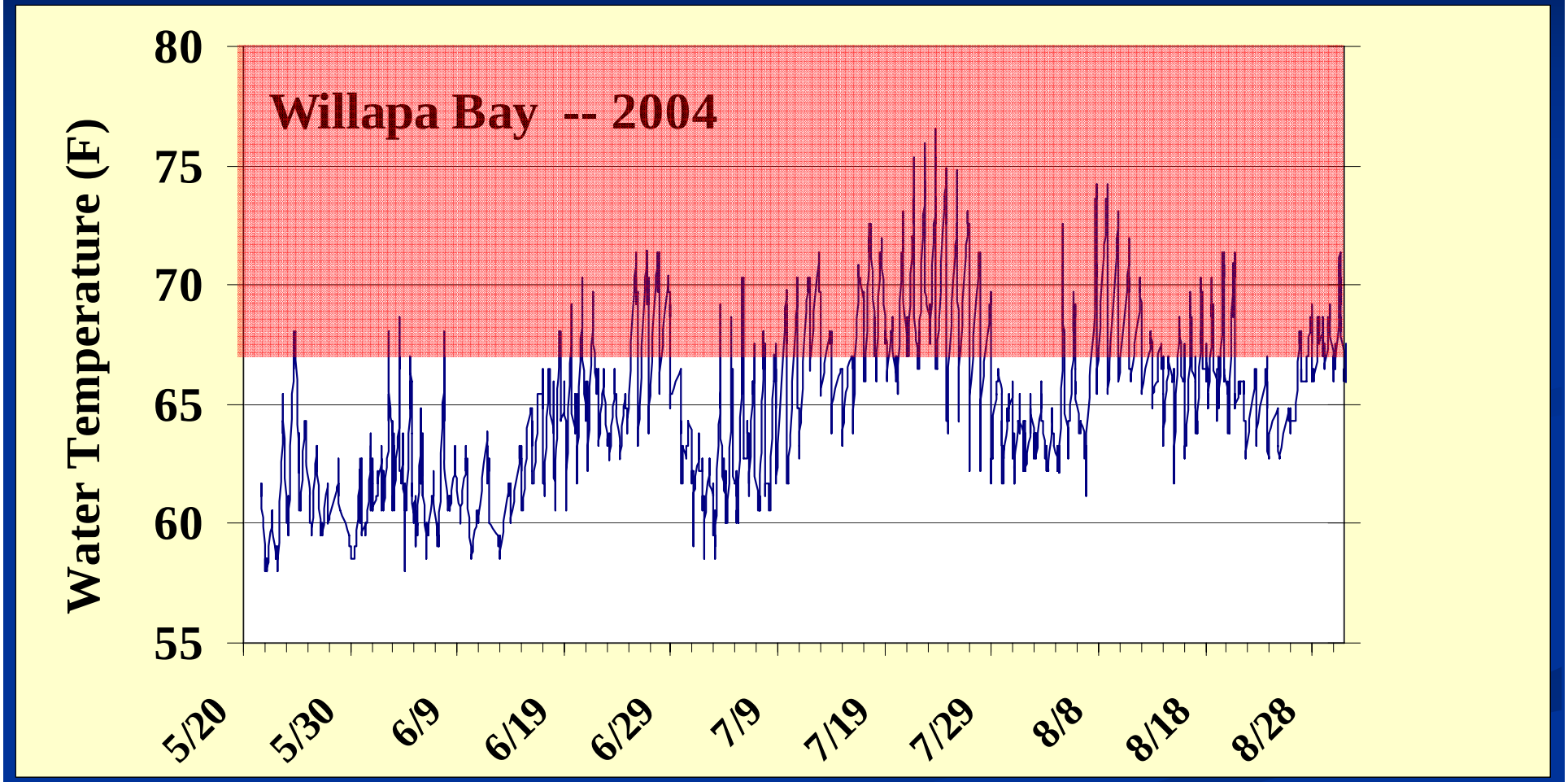
Conclusions from Alaska study

- Extends by 1000 km the northernmost documented source of oysters that caused illness due to *Vibrio*
- Rising temperatures of ocean water seem to have contributed to the timing and severity of the event.
- Was one of the largest known outbreaks in the United States, exceeded only by events in Washington and Texas
- Raises concern of more serious water-borne diseases

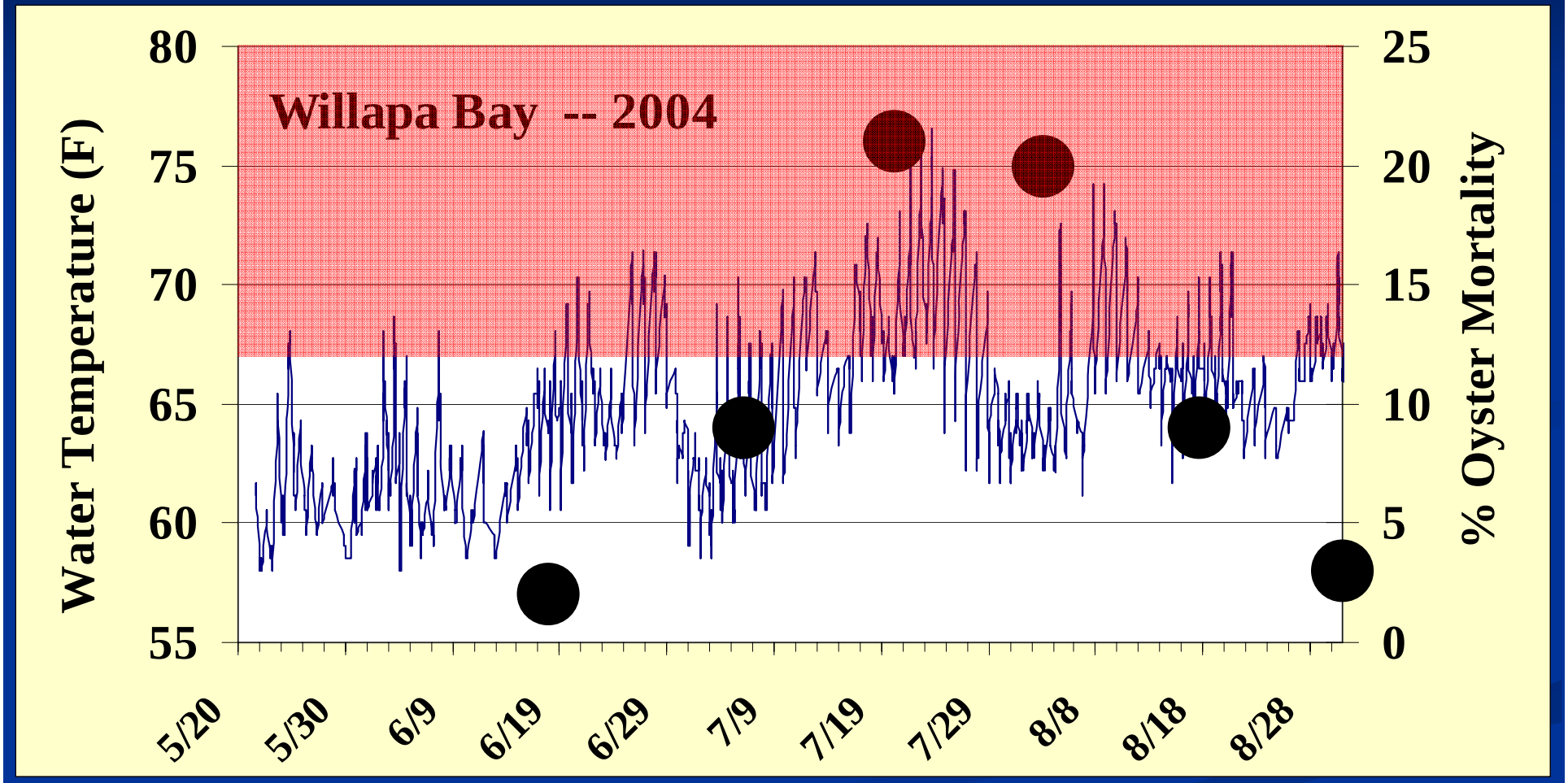
Shellfish Mortality and Water Temperature



Water temperatures above 66 F or 19 C place oysters at risk



Actual mortalities of yearling oysters in Willapa Bay



General effects of temperature rise

- Possibility for invasive species or diseases to become established
- Changes in the spawning timing and/or intensity – more spawning events
- Altered types (+/-) or timing of food resources
- Potential shift of suitable culture environments
- Better working conditions for shellfish farmers during the winter

Sea level change

- Present condition – 75 days

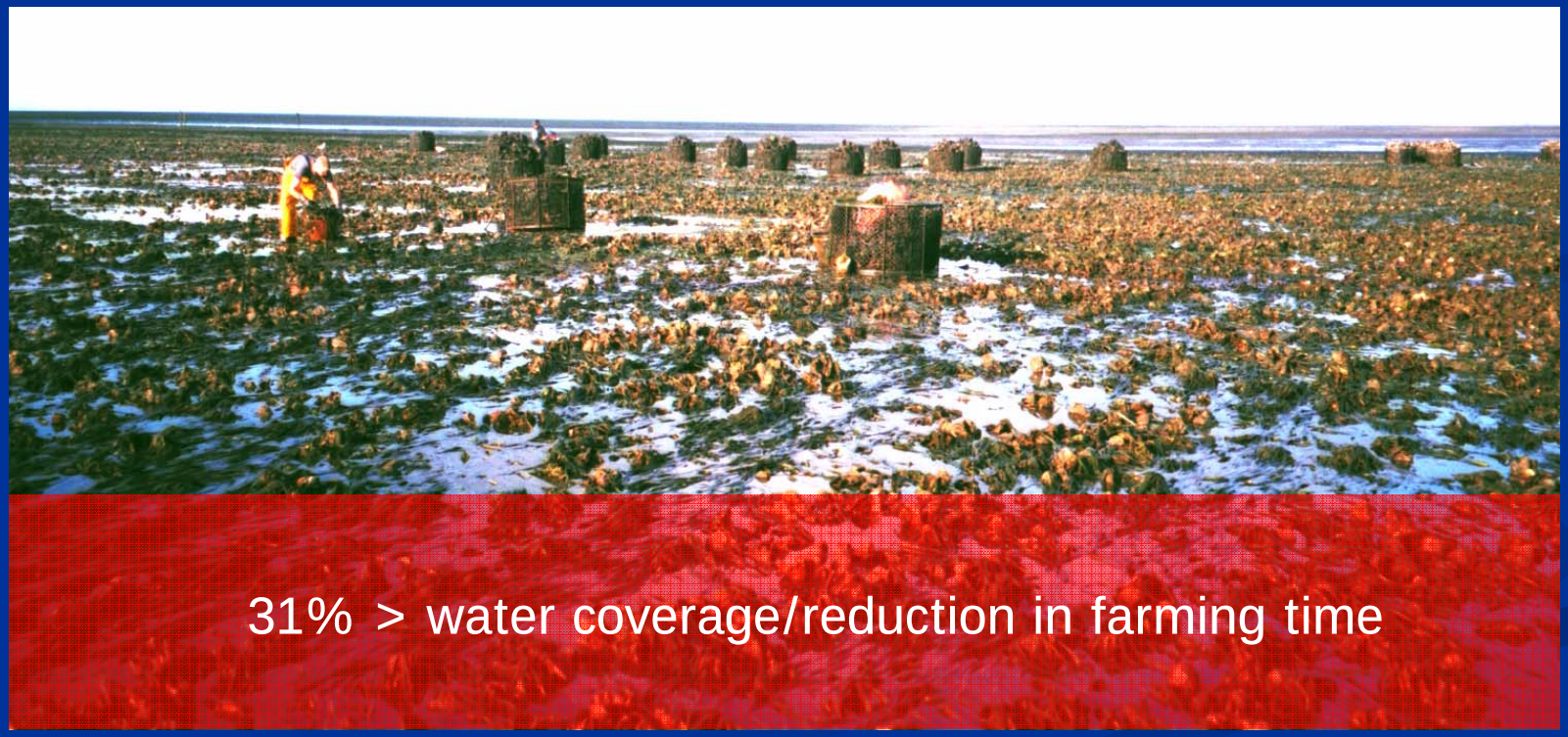
Sea level change

- 6 inch rise – 65 days

13% > water coverage/reduction in farming time

Sea level change

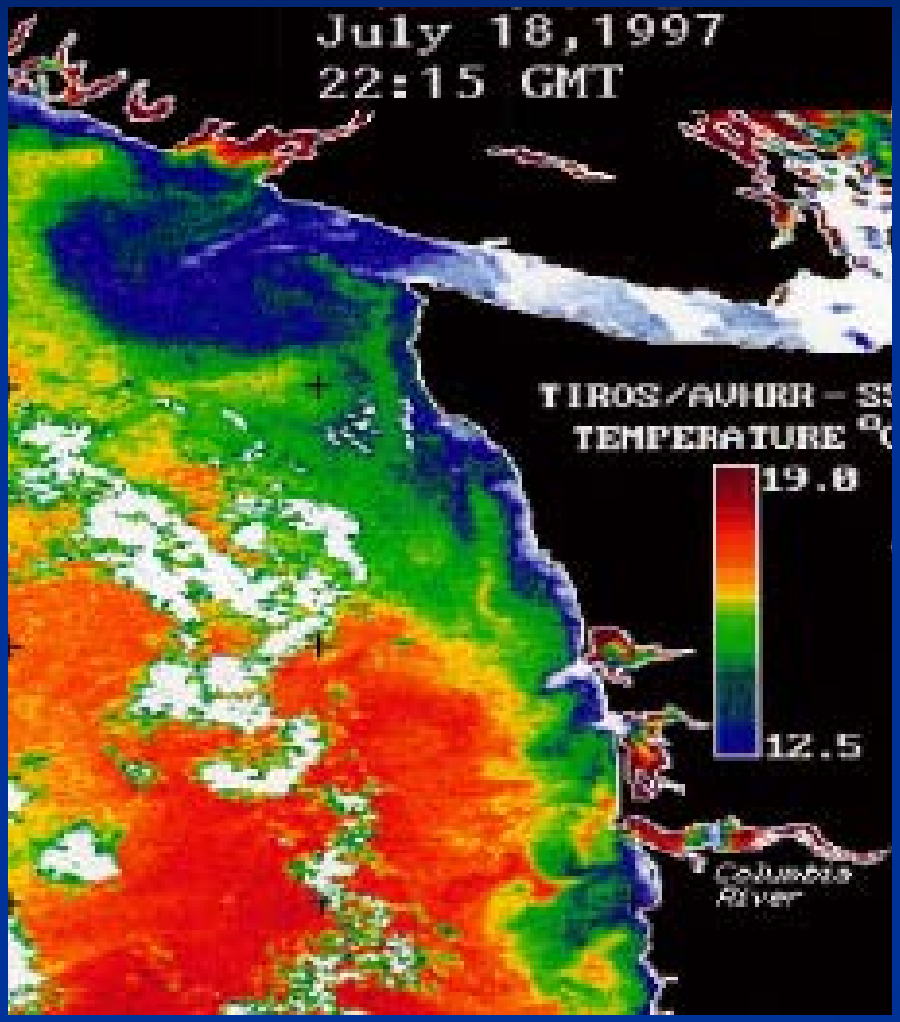
- 1 ft rise – 52 days



General effects of sea level rise

- Alters timing and access to shellfish grounds
- Alters optimal growing areas
- May shift optimal growing areas off the farmer's property
- May alter patterns of predation and exposure
- May require modification or replacement of shore-based facilities

Water currents and circulation



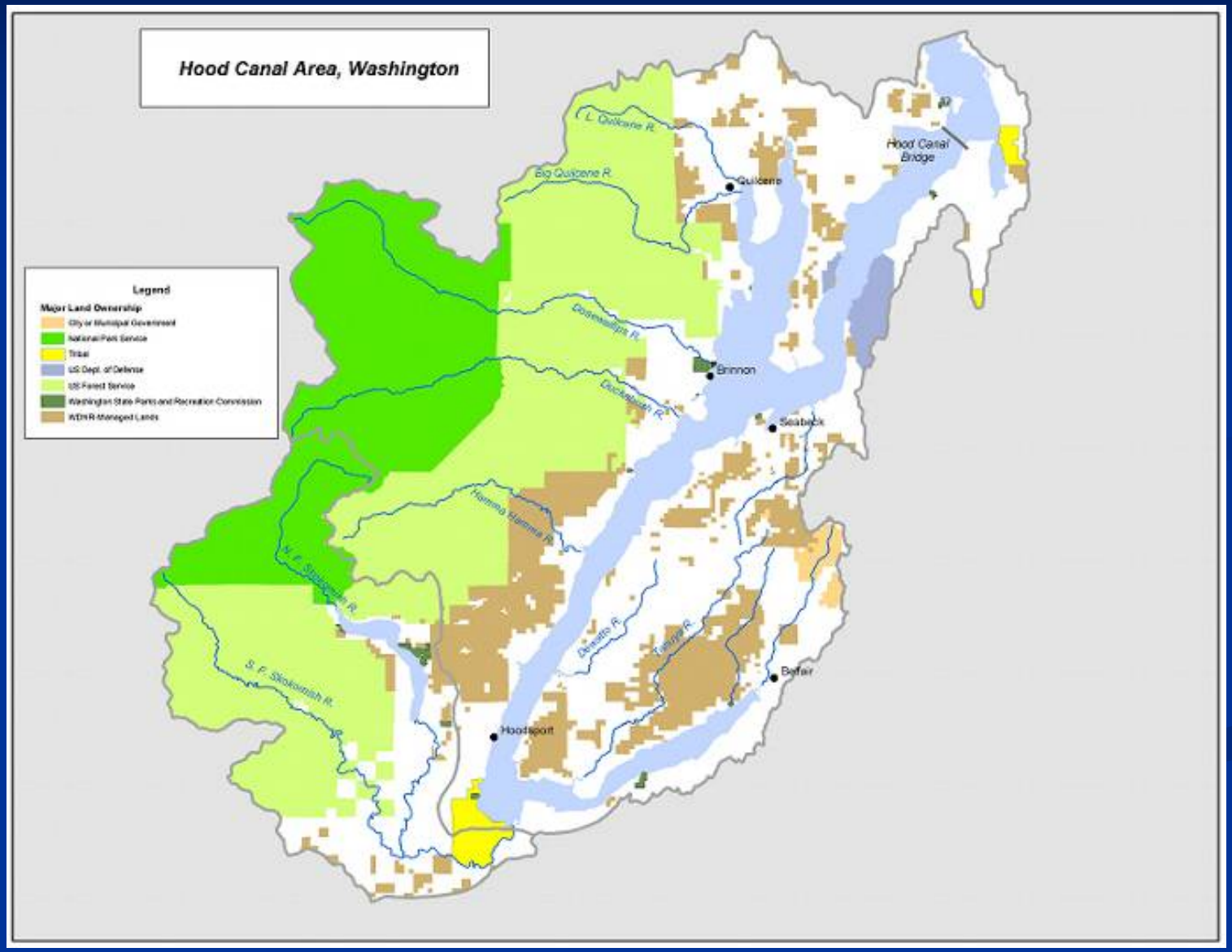
"*Highest levels of domoic acid ever recorded in the inland waters prompt closure*"

Spartina – 100's of acres in 1982 to 15,000+ acres in 2002

General effects of altered water currents

- Movement of toxic algae blooms into coastal and inshore waters
- Changes in nutrient levels and distribution in coastal estuaries
- Modification of larval and juvenile shellfish transport
- Potential for expanded distribution of invasive species

Freshwater runoff



General effects of freshwater runoff

- Reduced salinity of surface waters, with possible mortalities during extreme events
- Increased stratification, especially in circulation-limited waters
- Changes in phytoplankton types or distribution
- Increased shellfish closure periods in areas with water quality restrictions tied to rainfall events

Extreme events

Summary

- Changes (increased) water temperature are already having an effect on shellfish in the PNW
- Sea level rise due to increased temperature coupled with subsidence will alter aquaculture practices
- Increases in invasive species and HABs are likely
- Localized to regional effects are likely with increased freshwater runoff
- Great harm may occur due to major storms